Relevant Research and Results . . .Yesterday, Today, and Tomorrow

Transparent Urban Structures
Enabling Capability Program
BAA 07-035
Industry Brief

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Office of Naval Research, Code 30

June 2007

Transparent Urban Structures (TUS)

Collect, Understand, and Disseminate Intelligence for the Close-in Urban Fight

Urban Situational Awareness
Actionable Intelligence

- Determine Intent of Structures:
  - Detect and classify threats inside buildings and underground
  - Map the urban terrain in three dimensions, inside and out
- Process the data to make it understandable and actionable
- Get the right data to the right user quickly

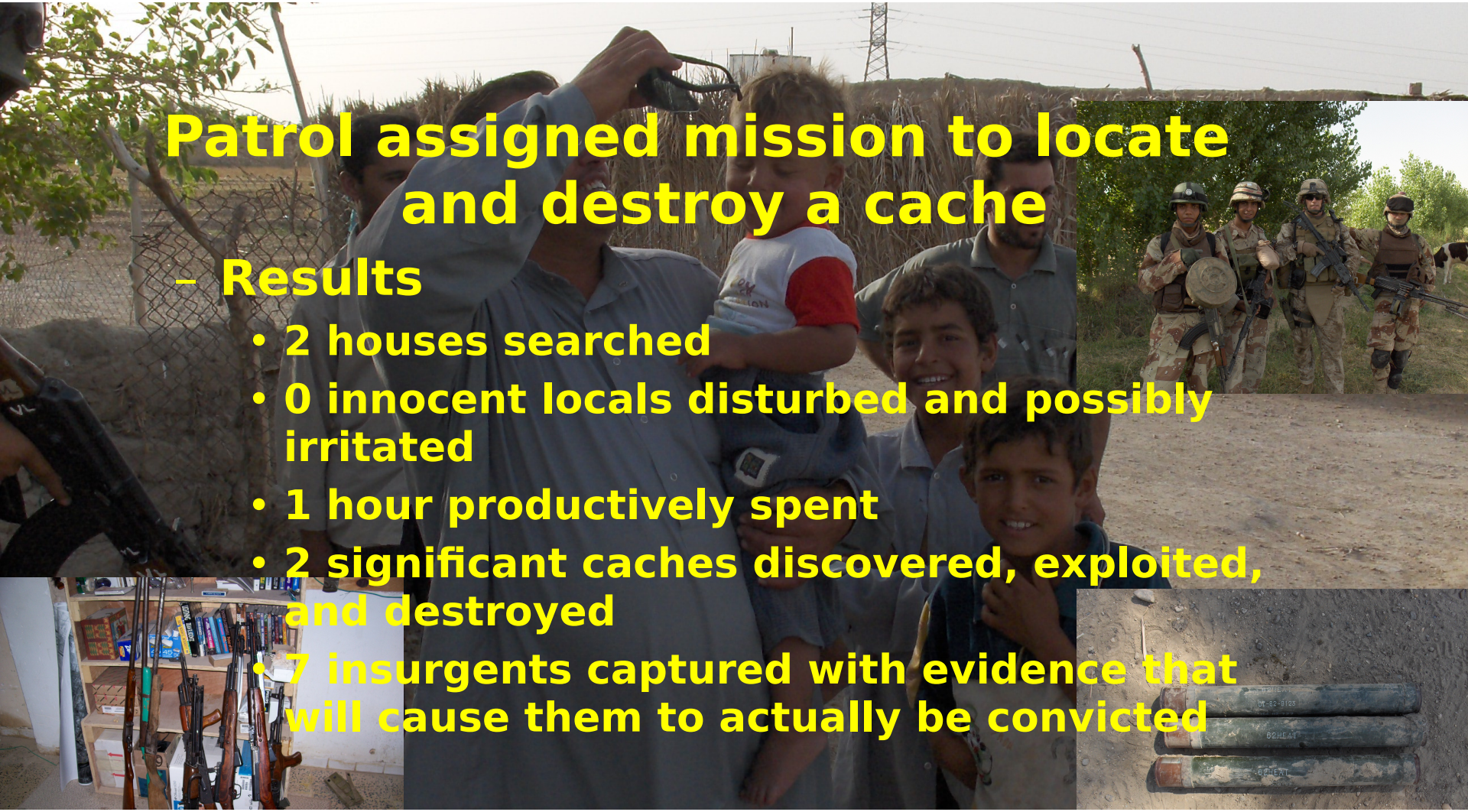
Make urban man-made structures transparent

User Perspective - Current Example

Patrol assigned mission to locate and destroy a cache

- Results
  - 20 houses searched
  - 200 innocent locals disturbed and possibly irritated
  - 4 hours wasted
  - NOTHING FOUND

User Perspective - Example with TUS



Patrol assigned mission to locate and destroy a cache

- **Results**
  - **2 houses searched**
  - **0 innocent locals disturbed and possibly irritated**
  - **1 hour productively spent**
  - **2 significant caches discovered, exploited, and destroyed**
  - **7 insurgents captured with evidence that will cause them to actually be convicted**

User Desires

- Observe and Orient portion of decision cycle vastly enhanced
- Actions can be focused on identified enemy locations, allowing for more surgical operations
- Decreased troop-to-task because of better information
- Better relations with the locals because of increased effectiveness and because you are hassling them less
- Less ability for the enemy to egress from or ambush CF forces while conducting operations.

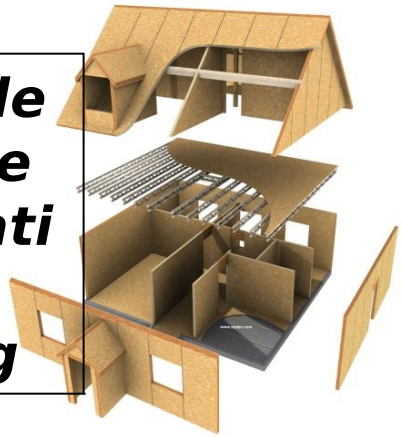
Focus

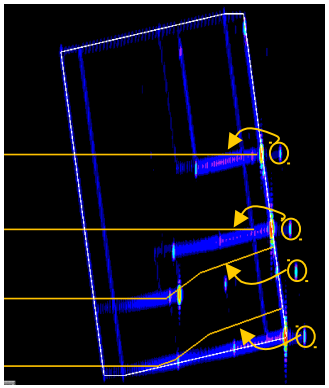
- Expeditionary unit focus
  - Marine Corps
  - SOCOM
  - Navy Expeditionary Combatant Command
- Relevant to:
  - Global War on Terror
  - Distributed operations

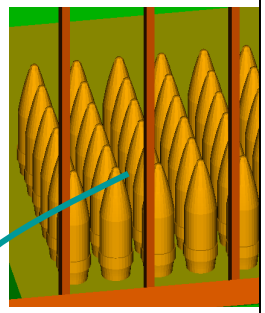
TUS General Program

Relevant Research and Results . . .Yesterday, Today, and Tomorrow

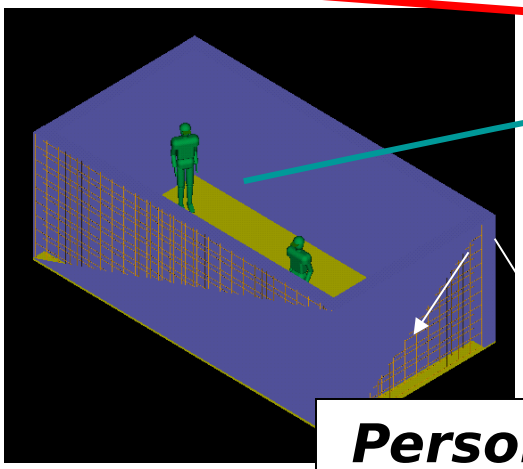
Man-made Structure Classification, Mapping



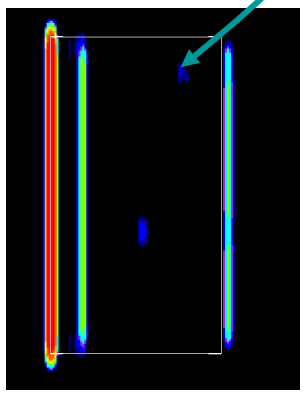


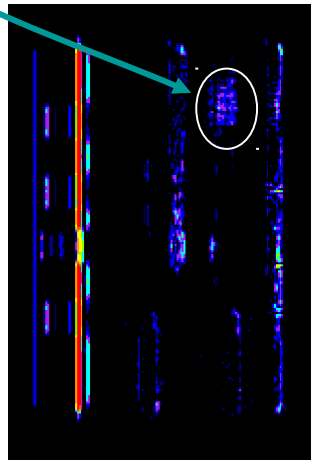


Weapons / Explosives Detection



Personnel Location and Intent





Actionable Intelligence Enabled by Data Fusion

TUS: Distinguishing Features

- Addresses need for tactical Marine Corps solution
  - **Small form factor narrow view and wide area sensor** systems
  - Intuitive and **tactically relevant display** technology
  - Convert “blobology” to actionable intel
- Activity classification behind walls in small form factor
  - Determine **intent** of personnel behind walls
  - Integration of all forms of Intel to make determination
- Sensor development by understanding phenomenology
  - **Unambiguous** determination of number and location of personnel behind walls
  - **High resolution** at low penetrating frequencies
  - Development of waveform agile sensors
- Expanded exploration of exploitable features
  - Presence and location of weapons/explosives
- Fills key gaps in technology and performance limitations of current sensors not addressed by Army STTW and DARPA Visibuilding

TUS Products

- Product 1: Sense Through Structures
  - Sensor development informed by phenomenology
- Product 2: Image and Map Facilities
  - Hardware and algorithms for 3D mapping of man-made structures
- Product 3: Decision Aids
  - Planning, analysis and visualization technologies for penetrating sensors

FY07 TUS Efforts

1. **High resolution UWB radar sensor using biometric classification**
   - Multiple beams for rapid scanning
   - Differentiate animates by biometric signatures (posture sway, respiration, heart beat)

2. **Airborne/HMMWV impulse synthetic aperture radar sensor**
   - High resolution for ID of personnel and weapons
   - Use interferometry to obtain third dimension

3. **Radar sensor for low frequency RF resonance signature analysis**
   - Development of resonance feature set and library at HF to UHF for various materials, unique shapes, and building features

4. **Joint acoustic and RF analysis of detecting and classifying objects behind walls**
   - Specific material ID based on acoustic induced vibration and RF polarimetry

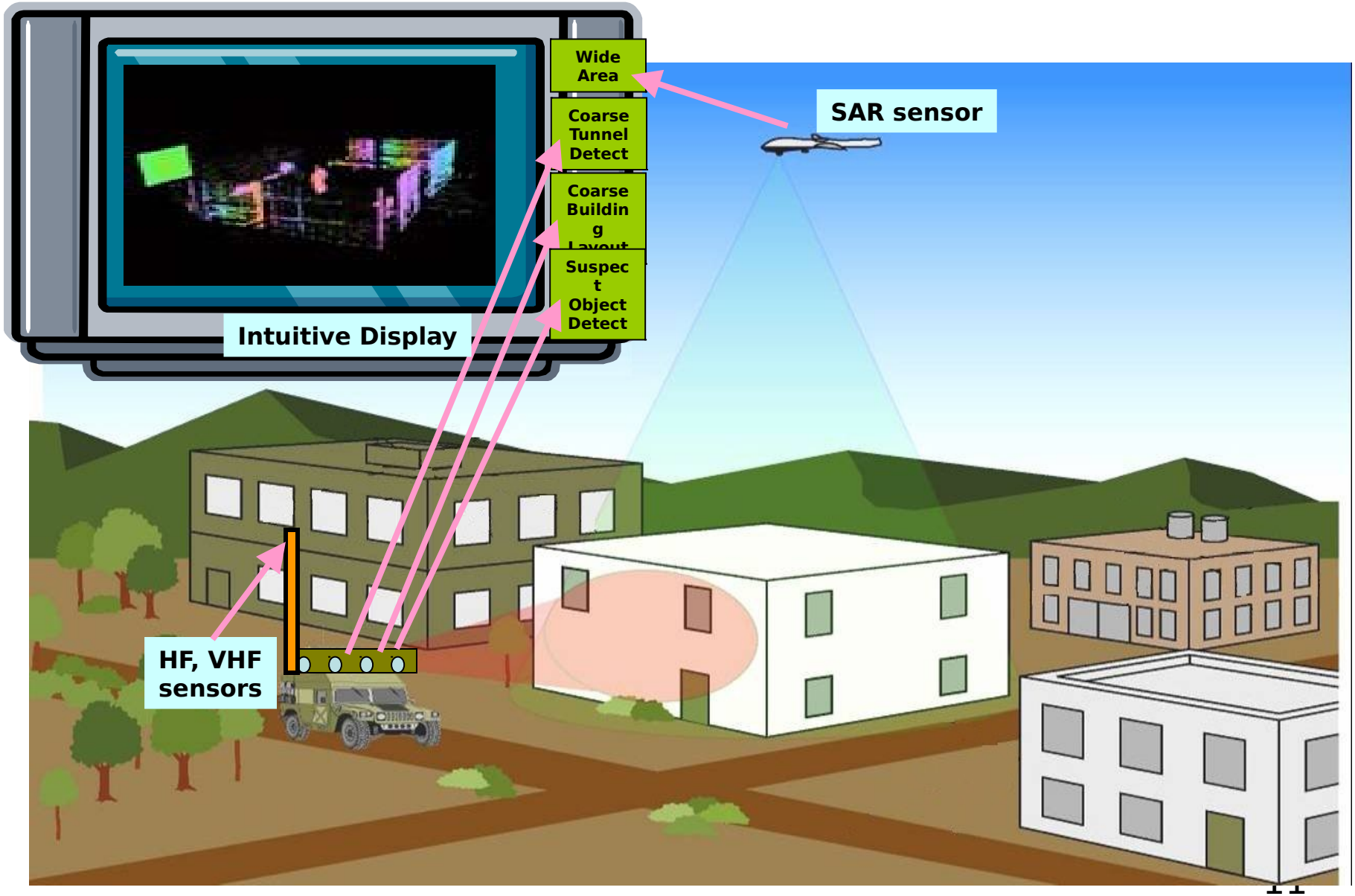
5. **Multi-platform R&D effort using array of agile RF sensors for analyzing frequencies, waveforms, polarization, multipath, and platforms**
   - Development of high resolution low frequency RF sensor
   - Phenomenology investigations and testing of high clutter sorting algorithms

6. **Passive sensing, geo-location and ID of unintended RF emitters emanating from within structures**

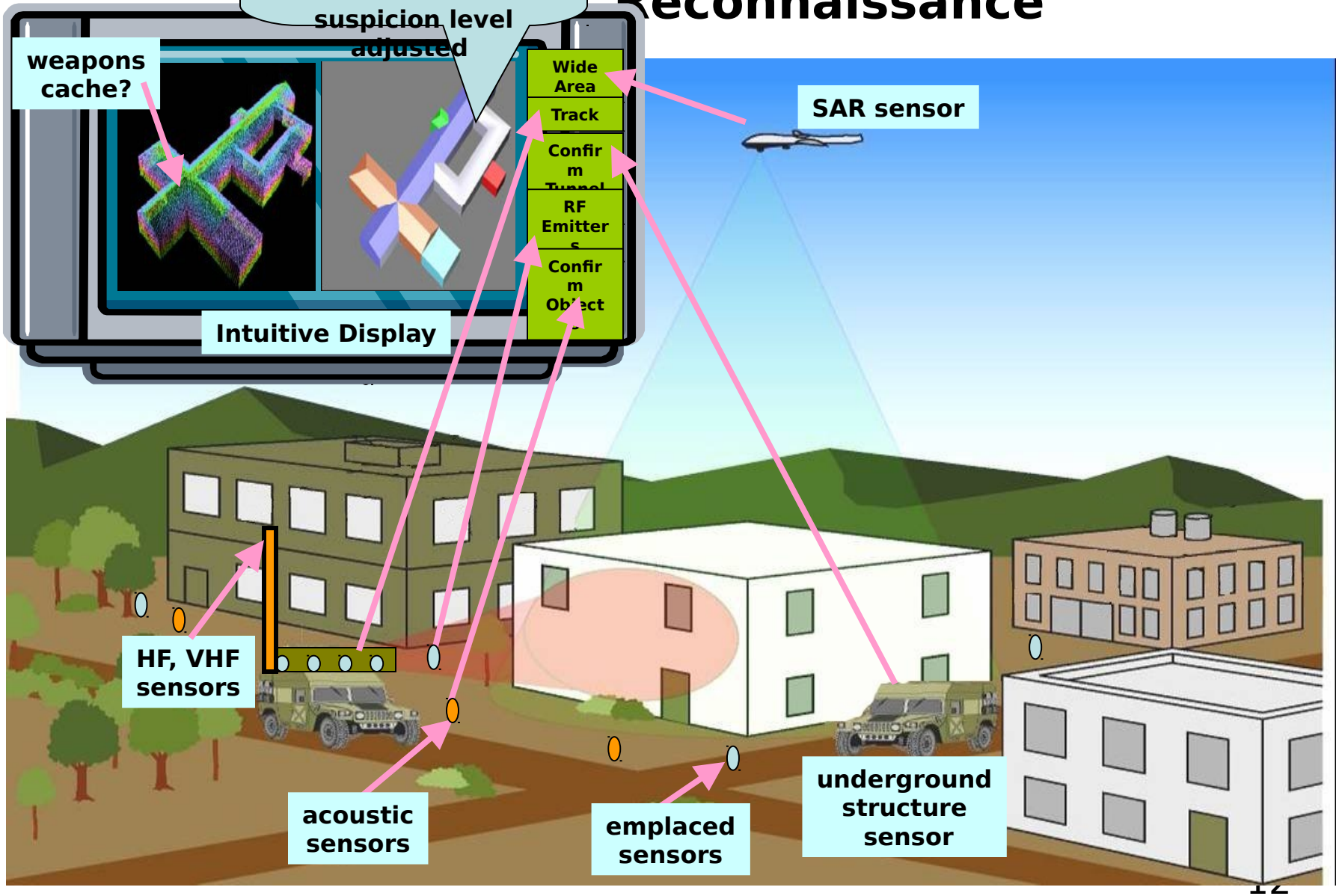
7. **Underground structure detection using atom interferometer based gravity sensor**

8. **Classify decisions by integrating STS data, existing intelligence, and geo-cultural/ontology information into activity pattern library for each structure**

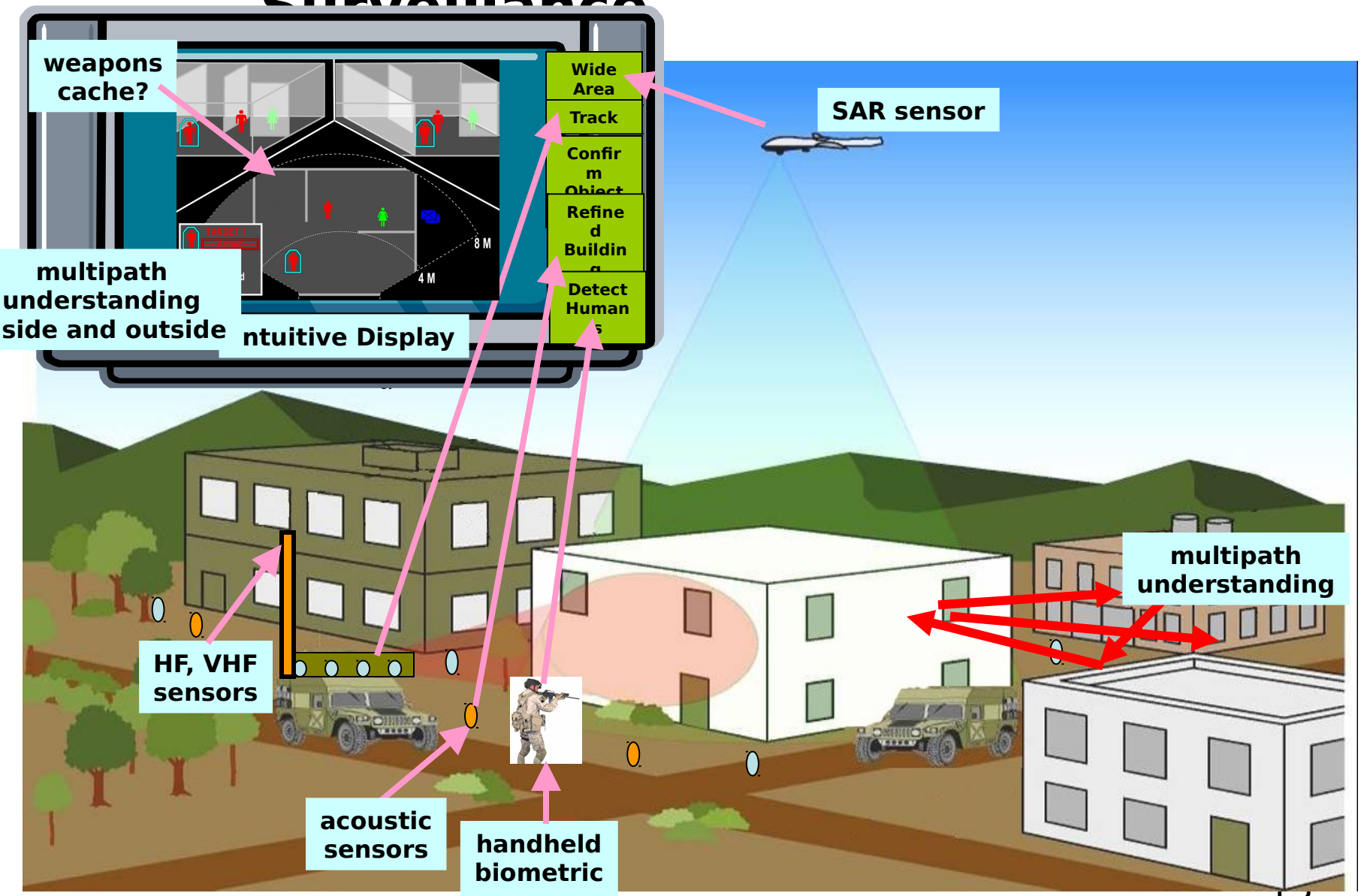
TUS Integration Wide Area Surveillance



TUS Integration Reconnaissance



TUS Integration Close-In Surveillance



FY08 TUS BAA 07-035

Gaps to be covered in FY08 program

- **Methods for finding small weapons caches and explosives**
  - Intent determination of personnel detected within structures is facilitated by the presence of weapons and explosives
  - Systems will provide standoff detection and location of hand-held firearms, small weapons, weapons caches and bulk explosives within structures
  - May require exploiting characteristic features such as chemical, spectral or structural signatures of armaments in addition to raw high-resolution imagery

- **Use of multisensor networking to improve resolution**
  - Image resolution and signature enhancement of object detection, localization and identification by a wireless network of multiple through-wall sensors functioning cooperatively providing multiple angle perspectives of the same scene
  - Image resolution at RF frequencies is improved by coherent integration of raw sensor data
  - Challenging for a wireless based network since sensor timing and position must be accurately known

- **Intelligent collection methods**
  - The enemy is able to locate himself in amongst the population and the urban setting making it extremely difficult to distinguish between innocents and the enemy, or to strike the enemy kinetically without causing collateral damage
  - Every searched structure that fails to result in useful intelligence, translates to time lost and unnecessarily disturbed innocent civilians
  - Development of capabilities that will increase the efficiency and effectiveness of area search missions
  - Sense-through-wall content from these ground sensors will be cohered with content obtained from other sensors and intelligence sources and propagated in real time to the appropriate levels of command.

FY08 TUS BAA 07-035 (cont.)

- **Urban information data base**
  - Warfighter accessible repository tool that integrates all forms and sources of urban information for a specified region of interest.
  - The distributed data structure provides a map-grid indexed organization of all relevant data sources
  - Exploiting the aggregation of these data products from different sources creates new useful data products for expeditionary forces

- **Intuitive display technology**
  - Develop virtual environments and related algorithms that interpret the raw sensor data automatically and intuitively display the information appropriate for tactical operations.
  - Convert “blogology” detections in raw RF imagery from cues in the raw radar sense data to a rendering of a virtual object (e.g. chair, human, construction feature) onto a simulated image of the building
  - Virtual representations of building interiors will be embedded within available real imagery of the urban area, allowing a warfighter to have one seamless visualization environment
  - Intelligence and command and control information will be embedded within the visualization to enable the display the mission critical information

TUS 2007 Tentative Calendar

TUS BAA 07-035

BAA Publication	**29 June**
White Papers	**17 July**
Oral Presentations	**20-23 August**
Final Proposals	**2 October**

Proposal Evaluations by User Commands and Government Labs